

Substance Technical Guideline for Formaldehyde

Use with the Formaldehyde Rule, Chapter 296-856 WAC

This helpful tool is a guideline for both:

- General information about formaldehyde exposure
and
- Specific information about Formaldehyde solution called Formalin.
 - Formaldehyde is most commonly used as formalin, which is a solution that contains 37% formaldehyde in water.

When exposure is from resins capable of releasing formaldehyde, the resin itself and other impurities or decomposition products may also be toxic. You should be aware of the hazards associated with all materials you handle.

Specific information and guidance about formaldehyde are outlined in this helpful tool under the following topics:

- Formaldehyde Health Effects
- Formaldehyde Technical Data Sheet
- Exposure monitoring
- Exposure controls
- Personal Protective Equipment (PPE)
- Spills and Other Emergencies
- Emergency First Aid Response



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FORMALDEHYDE HEALTH EFFECTS

Both *acute* and *chronic* exposures to formaldehyde can cause adverse health effects.

Acute Exposures

- Acute exposures generally consist of single exposures to high concentrations of formaldehyde, which may occur during an uncontrolled spill or release of formaldehyde gas.
- Acute formaldehyde exposure effects are shown in Table HT-1, *Acute Health Effects of Formaldehyde Exposure*.



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FORMALDEHYDE HEALTH EFFECTS (CONTINUED)

Table HT-1
Acute Health Effects of Formaldehyde Exposure

Type of contact	Health Effects
Ingestion (swallowing)	Liquids containing 10% to 40% formaldehyde cause severe irritation and inflammation of the mouth, throat, and stomach. Severe stomach pains will follow ingestion with possible loss of consciousness and death.
	Ingestion of dilute formaldehyde solutions (0.03% to 0.04%) may cause discomfort in the stomach and pharynx.
Inhalation (breathing)	Formaldehyde is highly irritating to the upper respiratory tract and eyes.
	0.5 to 2.0 parts per million (ppm) may irritate the eyes, nose, and throat of some individuals.
	3 to 5 ppm also cause tearing of the eyes and are intolerable to some persons.
	10 to 20 ppm cause difficulty in breathing, burning of the nose and throat, coughing, and heavy tearing of the eyes
	25 to 30 ppm causes severe respiratory tract injury leading to inflammation and accumulation of fluid in the lung
	100 ppm is immediately dangerous to life and health. Deaths from accidental exposure to high concentrations of formaldehyde have been reported.
Skin	Formaldehyde is a severe skin irritant and a sensitizer.
	Contact with Formaldehyde causes white discoloration, smarting, drying, cracking, and scaling.
	Prolonged and repeated contact can cause numbness and a hardening or tanning of the skin.
	Previously exposed persons may react to future exposure with an allergic eczematous dermatitis or hives.
Eye	Formaldehyde solutions splashed in the eye can cause injuries ranging from transient discomfort to severe, permanent corneal clouding and loss of vision.
	The severity of the effect depends on the concentration of formaldehyde in the solution and if the eyes are flushed with water immediately after the incident. Note: The perception of formaldehyde by odor and eye irritation becomes less apparent over time, as one gets used to formaldehyde exposure. This can lead to a hazardous exposure if a worker is relying on odor or irritation to alert them to the potential for exposure.



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FORMALDEHYDE HEALTH EFFECTS (CONTINUED)

Chronic exposures

- Chronic exposures are the result of exposure to low levels of formaldehyde over a period of time. Because of the low level exposure, the employee may not be aware of any immediate symptoms of exposure.
- The effects of chronic formaldehyde exposure can include the following:
 - Cancer
 - In humans, formaldehyde exposure has been associated with cancers of the lung, nasopharynx and oropharynx, and nasal passages. Repeated and prolonged exposure increases the risk.
 - Various animal experiments have conclusively shown formaldehyde causes cancer in rats.
 - Damage to DNA
 - DNA breaks
 - Sister chromatid exchange (DNA transfer during cell division)
 - Other chromosomal abnormalities.
 - Respiratory impairment
 - Some persons have developed asthma or bronchitis following exposure to formaldehyde, most often as the result of an accidental spill involving a single exposure to a high concentration of formaldehyde.
 - Structural changes in the epithelial cells in the human nose have been observed.
 - Rats exposed to formaldehyde at 2 ppm developed benign nasal tumors and changes of the cell structure in the nose as well as inflamed mucous membranes of the nose.



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FORMALDEHYDE TECHNICAL DATA SHEET

- General and specific information about Formaldehyde is outlined in the Formaldehyde Technical Data Sheet. This information can be used to inform and train your employees about the safe handling practices and hazards of formaldehyde in your workplace.
- Specific training requirements are found in Training, WAC 296-856-20020, in this chapter.
 - You should modify your training according to the actual products used.
 - Product specific information can be obtained from the material safety data sheet you receive with the product, or from the manufacturer or supplier.



Note:

- The precise hazards from exposure to formaldehyde depend on both of the following:
 - The form (solid, liquid, or gas) of the material
 - The concentration of formaldehyde present
- For example, spills or splashes from 37% to 50% solutions of formaldehyde present a much greater hazard to the skin and eyes than from solutions containing less than 1% formaldehyde.



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FORMALDEHYDE TECHNICAL DATA SHEET

Formaldehyde Synonyms

- Formaldehyde
- Formic Aldehyde
- Paraform
- Formol
- Formaldehyde (Methanol-free)
- Fyde
- Formalith
- Methanal
- Methyl Aldehyde
- Methylene Glycol
- Methylene Oxide
- Tetraoxymethalene
- Oxomethane
- Oxymethylene

Chemical information

- Family: Aldehyde
- Formula: CH_2O
- Molecular weight: 30.03
- Chemical abstracts service number (CAS number): 50-00-0.

Components and Contaminants of Formaldehyde in Formalin solutions

- 37.0% formaldehyde
- 63.0% water.
- Formic acid (alcohol free)
- Paraformaldehyde

Note:

Inhibited solutions contain 10-15% methanol.

Exposure limits

- Time-weighted average (TWA) - 0.75 ppm
- Short-term exposure limit (STEL) - 2 ppm



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FORMALDEHYDE TECHNICAL DATA SHEET (Continued)

Physical properties

- Colorless liquid with a pungent odor
- Boiling point: 214°F (101°C)
- Specific gravity: 1.08 (H₂O = 1 @ 20 C)
- pH: 2.8-4.0
- Solubility:
- Miscible In water
- Solvent is soluble in alcohol and acetone
- Vapor density: 1.04 (Air = 1 @ 20 C)
- Odor threshold: 0.8-1 ppm.

Fire and explosion hazards

- Moderate fire and explosion hazard when exposed to heat or flame.
- Reaction with the following substances yields explosive compounds:
 - Nitrogen dioxide
 - Nitromethane
 - Perchloric acid and aniline
 - Peroxyformic acid
- Flash point: 185°F (85°C) closed cup.
Note:
Although the flash point of 37% formaldehyde solutions is above normal room temperature, the explosion range is very wide:
 - Lower explosion limit: 7% by volume in air
 - Upper explosion limit: 73% by volume in air
- Autoignition temperature: 806°F (430°C)
- Flammable class (WISHA): III A
 - Extinguishing media: Use the following:
 - Dry chemical
 - "Alcohol foam"
 - Carbon dioxide
 - Water in flooding amounts as fog
 - Solid streams may not be effective.
 - Flushing spills with water spray can dilute them to produce nonflammable mixtures. However, water runoff should be contained for treatment.
 - Cool fire-exposed containers with water from the side until well after fire is out.



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FORMALDEHYDE TECHNICAL DATA SHEET (Continued)

➤ National Fire Protection Association Section 325M Designation:

- Health:
 - 2-Materials hazardous to health, but areas may be entered with full-faced mask self-contained breathing apparatus that provides eye protection.
- Flammability:
 - 2-Materials which should be moderately heated before ignition will occur. You may use water spray to extinguish the fire because the material can be cooled below its flash point.
- Reactivity:
 - D-Materials which:
 - In themselves are normally stable even under fire exposure conditions and
 - Are not reactive with water.

Normal fire fighting procedures may be used.

Reactivity

➤ Stability:

- Formaldehyde solutions may self-polymerize to form paraformaldehyde which precipitates.

➤ Incompatibility (materials to avoid):

- Strong oxidizing agents, caustics, strong alkalies, isocyanates, anhydrides, oxides, and inorganic acids. A violent reaction occurs when formaldehyde is mixed with strong oxidizers.
- Hydrochloric acid reacts to form the potent carcinogen, bis-chloromethyl ether.
- Nitrogen dioxide, nitromethane, perchloric acid and aniline, or peroxyformic acid reacts to yield explosive compounds.

➤ Hazardous combustion or decomposition products:

- Oxygen from the air can oxidize formaldehyde to formic acid, especially when heated.
- Formic acid is corrosive.

Health hazard data

➤ Acute animal toxicity

- Oral, rats: LD50 = 800 mg/kg
- Oral, mouse: LD50 = 42 mg/kg
- Inhalation, rats: LC50 = 250 mg/kg
- Inhalation, mouse: LC50 = 900 mg/kg
- Inhalation, rats: LC50 = 590 mg/kg



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EXPOSURE MONITORING

- Initial monitoring is performed when there is a potential for an employee to be exposed to airborne formaldehyde in the workplace. If the initial monitoring indicates an exposure at or above the action level, the employer is required to continue monitoring periodically as indicated in Exposure evaluations, WAC 296-856-20050, of this chapter.
- Procedures for exposure monitoring are contained in Table HT-2, Monitoring Procedures.

Table HT-2
Monitoring Procedures

Task	Guidelines for Monitoring procedures
Selection of Employees to Monitor	<ul style="list-style-type: none">➤ If an employee's exposure to formaldehyde could exceed the 0.5 ppm action level or the 2 ppm STEL, exposure should be monitored.<ul style="list-style-type: none">– A "representative" employee or employees will be asked to wear a sampling device to collect formaldehyde samples.– Notify the person conducting the monitoring if you have any difficulties wearing the device.
Sampling and analysis methods	<ul style="list-style-type: none">➤ If methods to accurately evaluate the concentration of formaldehyde in employees' breathing zone include one of the following:<ul style="list-style-type: none">– Collection of formaldehyde on liquid or solid sorbents with subsequent chemical analysis.– Short-term exposure may be measured by real-time continuous monitoring systems and portable direct reading instruments.➤ Measurements taken to determine time-weighted average (TWA₈) exposures are best taken with samples covering the full shift.➤ Samples collected should be taken from the employee's breathing zone air.➤ If there are tasks that involve brief but intense exposure to formaldehyde, employee exposure should be measured to assure compliance with the STEL.
Notifying employees of monitoring results	<ul style="list-style-type: none">➤ Your employer should inform you of the results of exposure monitoring representative of your work.➤ Your employer may inform you in writing, but may also post the results where employees have ready access to them.
Corrective action	<ul style="list-style-type: none">➤ Corrective actions should be taken when monitoring results are above the 8-hour time weighted average (TWA₈) or the 15-minute short-term exposure limit (STEL)<ul style="list-style-type: none">– Document any reason why exposures can't be lowered to below the PEL



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EXPOSURE CONTROLS

Exposure controls means the use of equipment, processes, and work practices to eliminate or minimize exposure. The following control methods may be used as appropriate for your workplace.

Ventilation

- Ventilation is the most widely used control method for reducing the concentration of airborne formaldehyde. There are two primary types of ventilation:
 - Local exhaust ventilation, designed to capture airborne formaldehyde as near to the point of generation as possible. To protect you, the direction of contaminant (air) flow should always be toward the local exhaust system inlet and away from you.
 - and**
 - General dilution ventilation, involving continuous introduction of fresh air into the workroom to mix with the contaminated air and lower the concentration of formaldehyde.
 - Effectiveness depends on the concentration of formaldehyde and the volume of air supplied.
 - This may be the only practical method of control where devices emitting formaldehyde are spread out over a large area.



Link:

NIOSH has published a control bulletin discussing ventilation controls for formaldehyde exposures during embalming. For further information on this subject visit

<http://www.cdc.gov/niosh/hc26.html>

Substitution

- One of the most effective methods of controlling exposure to formaldehyde is to substitute a safer, less toxic material where possible



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EXPOSURE CONTROLS (CONTINUED)

Enclosure

- Enclosure of the process is another preferred method of controlling worker exposure. The employee is prevented from coming into direct contact with the formaldehyde. The enclosure should be designed with a slight vacuum so that any leaks will result in the flow of external air **into** the enclosure

Isolation

- Employees may be isolated from direct contact with the work environment by the use of automated equipment operated by personnel observing from a closed control booth or room

Work Practices

- Work practices and administrative procedures are an important part of a control system. If you are asked to perform a task in a certain manner to limit your exposure to formaldehyde, it's extremely important that you follow these procedures
- Formaldehyde is incompatible with and reacts with strong oxidizers, alkalis & acids; phenols; urea; oxides; isocyanates; caustics; anhydrides



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PERSONAL PROTECTIVE EQUIPMENT (PPE)

This section addresses the selection and maintenance of protective equipment and clothing.

Skin protection

- Solutions containing greater than 1% formaldehyde are damaging to the skin and eyes. PPE adequate to prevent contact with such solutions needs to be provided to employees.
- Some solids that release formaldehyde and solutions that contain less than 1% formaldehyde can also pose a hazard to employees. In these instances, appropriate PPE needs to be provided in accordance with the general Personal Protective Equipment rule, WAC 296-800-160.
- Skin sensitization after exposure to high airborne concentrations has been reported. At concentration 100 ppm or more, the standard requires whole body protection.

Hand Protection

- Butyl and nitrile glove materials provide the greatest protection for the hands. Greater thicknesses of other materials (natural rubber, PVC, polyethylene) may be suitable for short use periods, but gloves may have to be changed more frequently due to degradation. All these materials are generally suitable for splash protection.
- Barrier creams aren't regarded as effective protection against formaldehyde

Respiratory protection

- Use NIOSH-approved full facepiece negative pressure respirators, with a change out schedule for the cartridges or canisters, or positive pressure supplied-air respirators as directed in chapter 296-842-130.
- In areas where the formaldehyde concentration might be 100 ppm or more, use complete body protection, including a positive pressure self-contained breathing apparatus (SCBA) with a full face piece or in combination with a supplied-air respirator.

Eye protection (For Formaldehyde solutions of 1% or more)

- If you might be splashed in the eyes with Formaldehyde, it's essential that you wear chemical resistant splash goggles or some other type of complete protection for the eye.
- You may also need a face shield in addition to eye protection to protect the face nose and mouth from splashes.



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SPILLS AND OTHER EMERGENCIES

There isn't a specific exposure level that triggers the emergency response provisions for formaldehyde and its solutions. When determining if there is a need to provide for emergencies, consider the worst possible emergency scenario, and whether the employees' lives or health are in jeopardy.

- Don't attempt to clean up a spill unless you are properly trained and equipped to do so.
- Follow the procedure established by your employer for Formaldehyde spills.
- For small containers, place the leaking container into a larger container that can be sealed or into a well-ventilated area, such as a laboratory hood.
- Take up small spills with absorbent material and place the waste into properly labeled and sealed containers for later disposal.
- For larger spills, you may be able to neutralize the spill with sodium hydroxide or sodium sulfite.
- Be aware of your emergency response plan if you work in an area where a large amount of formaldehyde could be released in an accident or from equipment failure.
- You should be trained in your specific duties in the event of a release, and it's important that you clearly understand these duties.
- Emergency equipment should be accessible and you should be trained to use any equipment that you might need. Clean formaldehyde contaminated equipment before reuse.
- If a spill of appreciable quantity occurs leave the area quickly, unless you have specific emergency duties.
 - Don't attempt to remove a victim, unless that's your assigned duty.
 - Don't touch spilled material.
 - Use water spray to reduce vapors.
 - Don't smoke, and prohibit all flames or flares in the hazard area.



Note:

The Department of Ecology has rules regarding the clean up of toxic waste and notify state and local authorities, when required.



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EMERGENCY FIRST AID RESPONSE

- The information in Table HT-3 provides guidance for emergency first aid response in the event of acute exposure to formaldehyde.
 - Acute exposure to formaldehyde can result in severe or life threatening injury.
 - Any person experiencing an acute formaldehyde exposure should be evaluated by a physician
- If you are exposed to formaldehyde in an emergency situation and develop signs or symptoms associated with acute toxicity from formaldehyde exposure, your employer should provide you with a medical examination as soon as possible.
 - This medical examination should include all steps necessary to stabilize your health.
 - If symptoms are severe, you may be kept in the hospital for observation to ensure that any delayed effects are recognized and treated.



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EMERGENCY FIRST AID RESPONSE (CONTINUED)

Table HT-3
Guidelines for Emergency First Aid Response

Emergency situation	Guidelines for responding
Ingestion (swallowing):	<ul style="list-style-type: none">➤ If the victim is conscious, dilute, inactivate, or absorb the ingested formaldehyde by giving milk, activated charcoal, or water. Any organic material will inactivate formaldehyde.➤ Keep affected person warm and at rest.➤ Get medical attention immediately.➤ If vomiting occurs, keep head lower than hips.
Inhalation (breathing):	<ul style="list-style-type: none">➤ Remove the victim from the exposure area to fresh air immediately.➤ If breathing has stopped, give artificial respiration.➤ Qualified first-aid or medical personnel should administer oxygen, if available, and maintain the patient's airways and blood pressure until the victim can be transported to a medical facility.➤ If exposure results in a highly irritated upper respiratory tract and coughing continues for more than ten minutes, the worker should be hospitalized for observation and treatment.➤ Keep the affected person warm and at rest.
Skin contact:	<ul style="list-style-type: none">➤ Remove contaminated clothing (including shoes) immediately.➤ Wash the affected area of your body with soap or mild detergent and large amounts of water until no evidence of the chemical remains (at least 15 to 20 minutes).➤ If there are chemical burns, get first aid to cover the area with sterile, dry dressing, and bandages.➤ Get medical attention if you experience appreciable eye or respiratory irritation.
Eye contact:	<ul style="list-style-type: none">➤ Wash the eyes immediately with large amounts of water occasionally lifting lower and upper lids, until no evidence of chemical remains (at least 15 to 20 minutes).➤ In case of burns, apply sterile bandages loosely without medication.➤ Get medical attention immediately. If you have experienced appreciable eye irritation from a splash or excessive exposure, you should be referred promptly to an ophthalmologist for evaluation.

